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(19)

(54) FILTRATION-COMPRESSION TYPE FILTER PRESS

(71) We, KURITA MACHINERY MANUFACTURING COMPANY LIMITED, a Japanese Corporation, of 2-1-44 Sakaigawa, Nishiku, Osaka, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a filter press of the so-called filtration-compression type wherein a slurry is fed under pressure and filtered by the feed pressure as a primary treatment and upon completion of this filtration the resulting filter cake remaining in each filter chamber is compressed by the expansion toward the associated filter chamber of the compression diaphragm which faces toward said filter chamber to effect further dehydration as a secondary treatment.

Among filter presses of this type is a well-known one wherein the surface of the compression diaphragm facing toward the associated filter chamber is made uneven to provide for filtrate drainage and for compression, thereby simplifying the construction. However, the use of the compression diaphragm for drainage and compression in such simple way is not effective to simplify the construction and operation to the same extent as the ordinary type filter presses. Thus, it is desired that this compression diaphragm for drainage and compression be installed on a filter press as a unit element which can be expanded and contracted and which can be installed and handled in the same way as in the filter plates of the ordinary type filter press. An approach to this problem is disclosed in U.K. Patent No. 1,035,190, comprising a bag-shaped compression diaphragm adapted to be fitted in a frame body by a core plate enclosed in said diaphragm to define a pressure fluid chamber in the diaphragm. With this approach, however, the compression diaphragm must be in the form of a bag with a core plate enclosed therein and the core plate must be substantially the same in size as the bag so as to spread the bag. Therefore, the manufacture is difficult. Further, if the bag is constructed such that the slurry feed port extends therethrough, it is difficult to thicken the slurry feed port wall, even if fluid-tightness can be secured. Thus, there is a problem from the standpoint of strength. Moreover, the slurry feed port wall tends to be fatigued prematurely, failing to contract properly, thus impeding the smooth flow of the slurry into the associated filter chamber, causing unbalance of pressure. Therefore, the slurry feed port wall is protected by a grommet to assure smooth flow of the slurry but the appurtenant construction is complicated and the range of expansion and contraction, i.e., the effective compressible area of the diaphragm is limited by the grommet, thus decreasing the efficiency of dehydration by compression. Further, the boundary region between the compressed and uncompressed regions of the compression diaphragm defined by the grommet tends to be fatigued to higher degree than any other regions with the repetition of expansion and contraction and can be damaged, and for this reason the region in the vicinity of the boundary is made in the form of a highly expansible bellows to protect the boundary region against the influence of expansion and contraction. However, the formation of such bellows portion is very difficult in the case of a bag.

U.K. Patent Nos. 1,118,383; 1,307,853; and 1,330, 125 disclose other constructions wherein separate diaphragms are applied to the front and rear surfaces of a base plate or frame body. Since the front and rear diaphragms are independent of each other and simply applied to the base plate or frame, they are by far easier to manufacture

than said bag-shaped diaphragm. On the other hand, however, unless the two compression diaphragms applied to the base plate or frame are fixed to the latter, the handling is inconvenient and there would be danger of the diaphragms slipping off during the operation or handling. Bonding would be disadvantageous from the standpoint of replacement of diaphragms when worn out. Further, if individual compression diaphragms are fixed in position by separate fasteners, there result a plurality of fastening places. It is also known to fix the compression diaphragm in position by a grommet at the slurry feed port which extends through the compression diaphragm. The use of such grommets is essential for keeping the compression chamber fluid-tight, but requires a complicated appurtenant construction. Moreover, said use accelerates the fatigue in the boundary of the pressed portion of the compression diaphragm. When the compression diaphragm is applied to the frame, an annular spacer must be applied to the inside of the compression diaphragm, thereby further complicating the construction.

An object of this invention is to provide a filtration-compression type filter press which is operable in the same manner as in an ordinary filter press which performs filtration alone.

The invention therefore provides a filtration-compression type filter press comprising compression filter plates disposed between a fixed end plate and a movable end plate, each compression filter plate comprising a base plate centrally formed with an opening larger than a slurry feed opening and a filtration-compression diaphragm which comprises two flexible sheets which have uneven filter cloth-supporting surfaces and which are connected together by an integrally formed cylindrical portion thereof extending through the opening in the base plate and formed with said slurry feed opening, said base plate and diaphragm co-operating with each other to define compression chambers, a filtrate outlet channel communicating with the filter chambers defined between the plates and a pressure fluid feed channel which opens to each compression chamber, said pressure fluid feed channel comprising main pressure fluid feed passage extending through the base plate and sheets of each filter plate and adapted to communicate with a pressure fluid feed port in the fixed end plate when the filter plates are clamped, and a pressure fluid feed sub-channel which establishes the communication between said passage and each compression chamber, while the filtrate outlet channel comprises a main filtrate outlet passage extending through the base plate and sheets of each filter plate and adapted to communicate with a filtrate outlet port in the fixed end plate when the filter plates are clamped, and filtrate outlet sub-channels which communicate with said main filtrate outlet passage and which open to the uneven filter cloth-supporting surfaces defined by the sheet.

A feature of the present invention is that each of compression filter plates suitably disposed between a fixed end plate and a movable end plate comprises a base plate having a central opening considerably larger than the slurry feed port, and a filtration-compression diaphragm in the form of two flexible fluid-tight sheets to be applied to the front and rear surfaces of said base plate and having uneven surfaces with a filter cloth piece applied thereto, said diaphragm being formed with a cylindrical portion which connects said sheets and which extends through the opening in said base plate and defines the slurry feed port, said filtration-compression diaphragm being adapted to be mounted on the base plate by wadding one of said flexible fluid-tight sheets, passing it through the opening in the base plate and unfolding the wadded sheet.

According to this arrangement, the filtration-compression diaphragm has its front and rear sheets formed as a unit, but, distinct from a closed hollow body like a bag, it is easy to manufacture and can be simply mounted on the base plate. Further, the filtration-compression diaphragm will not slip off after being mounted and can be easily formed to have a sufficient thickness to provide the necessary strength to its slurry feed port wall. Therefore, the appurtenant construction heretofore required in mounting the sheets on the base plate is no longer necessary.

According to this arrangement, since the opening in the base plate is made sufficiently larger than the slurry feed port to pass the wadded sheet of the compression diaphragm through said opening, a displacement between the base plate and the compression diaphragm would take place. Therefore, means is provided for preventing such displacement. Since such displacement takes place downwardly in most cases as the compression diaphragm tends to slide downwardly, the displacement preventing means may be such as to simply interconnect the upper edges of the two sheets of the compression diaphragm along the upper edge of the base plate. Alternatively, it may be in the form of a displacement preventing ring fitted in a clearance between the opening in the base plate and the slurry feed port of the compression diaphragm to fill in the same or in the form of displacement preventing projections adapted to be fitted in the opening in the base plate.

These means are effective to prevent the

displacement between the base plate and the compression diaphragm and especially the displacement preventing ring and projections are capable of preventing displacement in any direction. Further, if the ring is split into two halves, the diaphragm can be easily mounted when one sheet is passed through the opening in the base plate. The fitting projections can be made integral with the compression diaphragm and the compression diaphragm can be fitted in the opening in the base plate at the same time as it is mounted on the base plate. Thus, with any of these methods, the assembly can be easily carried out. Further, the construction itself is much less complicated than the conventional ones. The size of the opening in the base plate can be adjusted by selectively using displacement preventing rings of different diameters or by suitably combining a plurality of such rings. This serves to set the size of the slurry feed port according to the kind of the slurry.

The provision of a pressure fluid feed channel communicating with a pressure chamber defined between the base plate and the compression diaphragm, a filtrate outlet channel in the compression diaphragm which opens to the filter support surface, and a pressure fluid bypass channel which allows the primary and secondary treatments or filtration and compression when the filter plates are clamped between the fixed and movable end plates and which communicates with said pressure fluid feed channel and opens to the filter support surface, allows the advantageous arrangement in which that the pressure fluid is valved to be admitted into the pressure chamber for compression of the cake and then bypassed to the filter surface through the bypass channel for forcing the filtrate to be discharged through the filtrate outlet channel.

Therefore, the filtrate separated by filtration and compression and remaining in the filter support surface grooves and outlet channel is forcibly discharged, so that when the filter plates are opened for cake discharge, there is no remaining filtrate which would flow out, and the filtrate recovery factor is improved. When dehydrated cakes are required, there is no danger of remaining filtrate flowind down to mix therewith and decreasing the dhydration factor.

Other features of the present invention will become more apparent from the following description and the accompanying drawings, which are given by way of example only.

In the drawings:-

Figure 1 is a side view, partly in section, of a filtration-compression type filter press showing an embodiment of the present invention;

Figure 2 is an enlarged view of a portion of Figure 2, clearly showing the path of flow of pressure fluid;

Figure 3 is a front view, partly broken away, of a compression filter plate shown in Figure 1;

Figure 4 is a front view of the filter plate of Figure 3, with its filter cloth piece removed;

Figure 5 is a front view, partly broken away, of an ordinary filter plate shown in Figure 1;

Figure 6 is a sectional view showing how the compression filter plate shown in Figures 3 and 4 is assembled;

Figure 7 is a perspective view, in section, of a compression filter plate according to a modification wherein means for preventing the displacement of a filtration-compression diaphragm relative to the base plate comprises connecting the upper edges of the sheets which constitute said diaphragm;

Figure 8 is a sectional view of another modification wherein means for preventing the displacement of a filtration-compression plate relative to the base plate comprises hooking the upper edges of the sheets of the filtration-compression diaphragm;

Figure 9 is a front view, partly broken away, of a further modification wherein the filtration-compression diaphragm is provided with displacement preventing means which is engageable with the opening in the base plate;

Figure 10 is a central sectional view of Figure 9;

Figure 11 is a sectional view showing how the filtration-compression diaphragm of Figure 9 is mounted on the compression filter plate;

Figure 12 is a front view of a compression filter plate, showing another embodiment wherein a displacement preventing ring is interposed between the opening in the base plate and the cylindrical portion of the filtration-compression diaphragm;

Figure 13 is a central sectional view of Figure 12;

Figure 14 is a sectional view showing how the filtration-compression diaphragm of Figure 12 is mounted on the comprssion filter plate;

Figure 15 is a perspective view of the displacement preventing ring shown in Figure 12;

Figure 16 is a sectional view showing the upper half of a modification wherein displacement preventing rings are utilized for adjusting the size of the opening in the base plate;

Figure 17 is a sectional view of a compression filter plate, showing another modification of displacement preventing means;

Figure 18 is an enlarged view of a portion of Figure 17; and

Figures 19 and *20* are fragmentary enlarged sectional views showing different modifications of the filtrate outlet channel in the compression filter plate.

Referring to an embodiment shown in Figures 1 through to 6, the numerals 1 and 2 designate machine frames which carry a pair of transversely spaced side bars 3. A fixed end plate 4 is provided at one machine frame 1, and at the other machine frame 2 there is provided a movable end plate 5 which can be advanced and retracted by a cylinder 6. The movable end plate 5, and a number of filter plates 7 of ordinary construction and improved compression filter plates 8, alternately disposed between said movable and fixed end plates 5 and 4, are movably supported on the side bars 3 by handles 15 projecting from their lateral surfaces. Each filter plate 7 of ordinary construction, as shown in Figures 1, 2 and 5, has uneven filter support surfaces 7*a* to which a filter cloth piece 9 is applied, whereas each compression filter plate 8, as shown in Figures 1 through 4, comprises a base plate 11 having an opening 11*a* sufficiently larger than a slurry feed port 10, and a filtration compression diaphragm 13 applied to the front and rear surfaces of said base plate to define compression chambers 12 therebetween. The compression diaphragm 13 comprises flexible fluid-tight sheets 13*b* of rubber or the like having uneven surfaces 13*a* applied to the front and rear surfaces of the base plate 11, and a cylindrical portion 13*c* extending through the opening 11*a* in the base plate 11, defining the slurry feed port 10 and interconnecting said sheets 13*b*. The application of the compression diaphragm to the base plate 11 is effected by folding one of the sheets 13*b* into two at the slurry feed port 10, wadding opposite sides around the slurry feed port 10, passing the wadded sheet 13*b* through the opening 11*a* in the base plate and unfolding the same, as shown in Figure 6. If the sheet wadded as shown in Figure 6 is bound as by a string, this facilitates the application. The compression filter plate 8 with the compresion diaphragm 13 mounted on the base plate 11 has a filter cloth piece 9 applied to the filer surfaces 13*a* defined by the sheets 13*b*.

The fixed and movable end plates 5 and 6 are disposed adjacent the compression filter plates 8 and, though not shown, their opposed surfaces are formed with filter support surfaces similar to the filter support surfaces 7*a* of ordinary filter plates 7 and filter cloth pieces 9 are applied thereto.

The filter plates 7 and 8, when clamped between the fixed end plate 5 and the movable end plate 6 as a result of the advance of the latter, contact each other through the filter cloth pieces 9, as shown in Figure 1, to define filtration chambers 14 between the filter support surfaces 7*a* and 13*a*. Each filtration chamber 14 adjoins a compression chamber 12 separated therefrom by a sheet 13*b* having a filter support surface 13*a*.

The filter plates 7 and 8 have main filtrate outlet channels 17*a* which communicate with filtrate outlet ports 16 formed in the fixed end plate 4 at the lower opposite corners thereof when the filter plates are pressed into contact with each other. Each filter plate 7 has a filtrate outlet sub-channel 17*b* which communicates with the left-hand side filtrate outlet channel 17*a* shown in Figure 5 and which opens to the filter support surface 7*a*, while each filter plate 8 has a filtrate outlet sub-channel 17*b* in the base plate 11 which communicates with the right-hand side filtrate outlet channel 17*a* shown in Figure 3 and which also communicates with the filter support surface 13*a* through through-holes 17*c* formed in the sheet 13. The filtrate outlet channel 17*a* extends through the base plate 11 and sheet 13*b*, opens to the marginal land 13*d* of the sheet 13*b* and is opposed to the outlet channel 17*a* which extends through the filter plate 7 and opens to the marginal land 7*b*. These outlet channels 17*a* in the filter plates 7 and 8 communicate with each other when the marginal lands 7*b* and 13*d* are pressed into contact with each other. The outlet channel 17*b* in the filter plate 8 communicates with the outlet channel 17*a* within the base plate 11 and opens to a position on the marginal land of the base plate 11 opposed to the through-holes 17*c* formed in the sheets 13*b* and also opens to a corner of the filter support surface 13*a* surrounded with the marginal land 13*d* through said through-holes 17*c*. The region of the filter support surface 13*a* where the throughholes are formed is opposed to an enlargement 7*b*′ of the marginal land 7*b* surrounding the filter support surface 7*a* and is clamped between said enlargement and the base plate 11 when the filter plates 7 and 9 are pressed into contact with each other, so that even if the compression diaphragm 13 is bulged as shown in the left-hand side of Figure 1 by feeding pressure fluid to the pressure chamber 12, the region of the sheet 13*b* where the through-holes 17*c* are formed will not separate from the base plate 11. Therefore, through-holes 17*c* and outlet channels 17*a*, 17*b* do not spoil the fluid-tightness of the compression chamber 12. The fixed end plate 4 has a filtrate outlet sub-channel 17*b* which opens to its filter support surface 13*a*, and main filtrate outlet channels 17*a* which communicate directly with the filtrate outlet ports 16, said sub-channel 17*b* communicating with one of said channels 17*a* as in the case of the filter plates 7, while the movable

end plate 5 has a filtrate outlet sub-channel 17*b* which opens to its filter support surface 13*a*, and main filtrate outlet channels 17*a* which communicate with the filtrate outlet ports 16 through the channels 17*a* formed in the filter plates 7, 8 and fixed end plate 4, said sub-channel 17*b* communicating with one of said channels 17*a* in said movable end plate, (Figures 1 and 3 through 5).

Filter plates 7, 8 and fixed and movable end plates 4, 5 have pressure fluid feed channels 19*a*, which become continuous with each other and communicate with a pressure fluid feed port 18 formed at one upper corner of the fixed end plate 4 when these plates are pressed into contact with each other, said channels 19*a* opening to the marginal lands of the respective plates. Each filter plate 8 is formed with a pressure fluid feed sub-channel 19*b* which communicates with the associated feed channel 19*a* within the base plate 11 and which opens to the compression chambers 12. Main dual-purpose feed channels 21*a* which communicate with a dual-purpose feed port 20 for washing water and pressure fluid formed at the other upper corner of the fixed end plate 4 also open to the marginal lands of the filter plates 7, 8 and end plates 4, 5. The filter plates 7 and 8 are formed with dual-purpose feed sub-channels 21*b* which communicate with the respective feed channels 21*a* and open to the filter support surfaces 7*a* and 13*a*. In addition, the feed channel 21*b* in each filter plate 8 opens to the filter support surface 13*a* through through-holes 21*c* formed at a corner of the filter support surface 13*a* which will be pressed against an enlargement 7*b*′ of the associated filter plate 7. A pressure fluid feed line 22 connected to the pressure fluid feed port 18 has its branch line 22*a* connected to a washing liquid feed line 23 connected to the dual-purpose feed port 20. Main valves V22 and V23 are located upstream of the branching point of the branch line 22*a* of the pressure fluid feed line 22 and upstream of a point at which said branch line is connected to the washing liquid feed line 23, respectively. Further, a valve V1 is provideed intermediate between the ends of the branch line 22*a* and a valve V2 is provided between the branching point of the branch line 22*a* and the feed port 18. A first discharge line 22*b* having a valve V3 placed therein is provided between the branching point of the branch line 22*a* and the valve V1, while a second discharge line 23*a* having a valve V4 placed therein is connected between the branching point of the washing liquid feed line 23 and the feed port 20, (Figures 1 through 3). The numeral 24 in Figure 1 designates a slurry feed port provided in the machine frame 1 and communicating with the individual filter chambers 14 through the slurry feed ports 10 in the fixed end plate 4 and filter plates 7 and 8.

When it is desired to effect filtration, the movable end plate 5 is advanced by the cylinder 6 to clamp the filer plates 7 and 8 between the movable and fixed end plates 4 and 5. In this condition, a slurry is fed from the slurry feed port 24 to the individual filter chambers 14. The slurry fed to the filter chambers 14 is filtered under the feed pressure as it tends to flow through the filter cloth pieces 9 to the filter support surfaces 7*a* and 13*a* defining the opposite lateral walls of the filtration chambers 14. The filtrate which has flowed to the filter support surfaces 7*a* and 13*a* flows down along the filter support surfaces 7*a* and 13*a* to enter the filtrate outlet sub-channels 17*b* which open to the filter support 7*a* and 13*a* and it is finally discharged through the filtrate outlet ports 16.

Upon the lapse of a predetermined period of filtration, the feed of slurry is cut off and pressure fluid is fed to the feed port 18 through the pressure fluid feed line 22. In this case, all the valves except the valves V22 and V2 remain closed, and the pressure fluid being fed flows from the main pressure fluid feed channels 19*a*, which are now continuous with each other, into the individual pressure fluid feed sub-channels 19*b* and then into the individual pressure chambers 12, whereby the filtration-compression diaphragm 13 of each filter plate 8 is bulged from a first position shown at the right-hand side of the Figure 1 section wherein the sheets 13*b* are in intimate contact with the base plate 11 to a second position shown at the left-hand side of said section wherein they are separated from the base plate 11, thereby compressing the cakes (not shown) for further dehydration resulting from said filtration and remaining in the filtration chambers 14. The resulting filtrate is discharged via the same path as in the case of the preceding filtrate.

Upon completion of the dehydration, the valve V22 is closed while leaving the valve V2 as it is, and the valve V1 is opened. As a result, the main pressure fluid feed channels 19*a* communicate with the washing liquid and pressure fluid feed channels 21*a* through portions of the feed lines 22 and 23 and the branch line 22*a*, so that the pressure fluid fed to the compression chambers 12 flows back until it enters the dual-purpose feed channels 21*a*. Then it flows through the dual-purpose feed sub-channels 21*b* to the filter support surfaces 7*a* and 13*a* of the filter plates 7 and 8, so that the filtrate remaining in the filtrate grooves in the filter support surfaces 7*a* and 13*a* is expelled through said filtrate discharge path. Accordingly, the filtrate recovery efficiency is improved and when cakes are required

there is no possibility that the filtrate remaining of the filter support surfaces 7*a* and 13*a* from which it is to be recovered will mix in the cakes to decrease the dehydration efficiency. Further, the pressure fluid for expelling the filtrate is mixed with the filtrate and discharged therewith. In this case, if compressed air is used as said pressure fluid, the resulting mixture is a gas-liquid one and the air will spontaneously dissipate without any trouble.

When this filtrate expelling operation is not to be performed only the valves V2, V3 and V4 are in an open condition after the dehydration of cakes so as to allow the pressure fluid used for compression to be discharged through the first and second discharge lines 22*b* and 23*a*.

The series of operations described above, which constitutes one cycle of filtering operation, is repeated for filtration of successive batches of slurry. Each time the slurry is fed, the valve V3 and V4 are kept open for a predetermined period of time to enable the slurry being fed to exhaust the air remaining in the filtration chambers 14. The timely operation of the individual valves may be automatically effected along with filtration according to a predetermined programme.

When filtration is repeatedly effected, the filter cloth pieces 9 will gradually clog, thus decreasing the filtration efficiency. In order to overcome this problem, the filter cloth pieces 9 are reversely washed periodically or when required during the progress of said programme. This reverse washing is effected by opening the valve V23 to feed washing liquid to the feed port 20 from the washing liquid feed line 23. The washing liquid thus fed flows through the main dual-purpose feed channels 21*a* and then through the dual-purpose feed sub-channels 21*b* to appear at the filter support surfaces 7*a* and 13*a*. The slurry feed channels are opened as washing liquid outlet channels are closed so that the air therein will not be forced out. The supplied washing liquid flows through the filter cloth pieces 9 in a direction opposite to that for the filtrate, i.e., from the filter support surfaces 7*a*, 13*a* to the filtration chambers 14. This reverse flow of washing liquid removes the remnant which sticks to the filter cloth pieces 9 or with which the latter clog, and washed it out of the filter press through the slurry feed channels. Therefore, it goes without saying that the slurry feed channels will be selectively connected to the slurry feed source and the washing liquid outlet port.

During each filtration, the filtration-compression diaphragms 13 are expanded and contracted once, and it might be feared that the cylindrical portions 13*c* would be fatigued to become incapable of sufficient expansion and contraction, interfering with the flow of slurry. However, each filtration-compression diaphragm 13 is an open body comprising two sheets 13*b* connected at the slurry feed opening 10 and is easy to form. As shown, the cylindrical portion 13*c* defining the slurry feed opening 10 can be a thickened portion whose wall is gradually thickened from the sheets 13*b* to avoid such fatigue. Further, since it is formed as a unit, there is no problem of fluid-tightness at the slurry feed openings 10.

An embodiment shown in Figure 7 provides displacement preventing means in the case where in order that a filtration-compression diaphragm 113 comprising two flexible fluid-tight sheet 113*b* connected together by a cylindrical portion 113*c* which defines a slurry feed opening 110 may be easily mounted on a base 111, an opening 111*a* is made sufficiently larger than the cylindrical portion 113*c*. Thus, the upper edges of the sheets 113*b* are connected together by rivets 130 so as to prevent the filtration-compression diaphragm 113 from being displaced under its own weight. The connection effected by said rivets is such that the distance S between the sheets 113*b* is narrower than the width B of the base plte 111 so that the upper edges of the sheets 113*b* may be hooked on the upper edge of the base plate 111. The sheets are interconnected at at least three places.

In Figure 8, the upper edges of sheets 213*b* are formed with bends 213*e* adapted to be hooked on the upper edge of a base plate 211 so as to prevent a filtration-compression diaphragm 213 from being displaced relative to the base plate 211 owing to a clearance defined between a cylindrical portion 213*c* and an opening 211*a*.

The sheets of the filtration-compression diaphragm can be given sufficient stiffness to prevent them from drooping, by suitably selecting the material or thickness of the sheets or by forming marginal lands. However, the construction of Figure 7 can eliminate such drawback and even the construction of Figure 8 is also effective for this purpose.

According to an embodiment shown in Figures 9 through 11, a cylindrical portion 313*c* on the rear surface of one or both of the pair of sheets 313*b* is peripherally provided with a number of radially extending fitting projections 313*f* formed around the cylindrical portion on the rear surface of one or both of the pair of sheets and adapted to be fitted in an opening 311*a* in a base plate 311, thereby preventing the displacement between the base 311 and a filtration-compression diaphragm 313. The projections 313*f* can be fitted in the base plate opening 311*a* when one sheet 313*b* is inserted in the opening 311*a* to mount the

compression diaphragm 313, as shown in Figure 11. Thus, the mounting operation is not made complicated. In this construction, the compression diaphragm 313 will not be displaced relative to the base plate 311 in any direction, and the projections 313*f* also serve to reinforce the slurry feed opening 310 and do not complicate the formation of the diaphragm.

According to an embodiment shown in Figures 12 through 15, a diametrically split two-piece ring 440 as shown in Figure 15 is interposed between an opening 411*a* in a base plate 411 and a cylindrical portion 413*c* which interconnects the sheet 413*b* of a filtration-compression diaphragm 413 at a slurry feed opening 410, thereby preventing the displacement between the diaphragm 413 and the base plate 411. If the ring 440 is mounted around the cylindrical portion 413*c* when one of the sheets 413*b* is about to be inserted in the opening 411*a* in the base plate 411, it can be automatically fitted between the cylindrical portion 413*c* and the opening 411*a* upon the insertion of the sheet, as shown in Figure 14. Therefore, it will not complicate the mounting of the compression diaphragm 413. The ring 440 may be made of rubber, metal or any other material. If it is made of rubber, it may be split at one place to provide for mounting while utilizing its elasticity.

If such rings 440 of different diameters are prepared, they make it unnecessary to replace the base plate 411 when it is desired to vary the size of the slurry feed opening 410 according to the kind of the slurry. As shown in Figure 16, if a combintion of three mating rings is prepared, the adjustment of the size of the slurry feed opening can be achieved by suitably selecting the number of rings to be employed. The number of rings in such combination and the construction thereof are optional. Each filtrate outlet sub-channel 417*b* comprises a groove formed in a marginal land 413*d* and extending from a main filtrate outlet channel 417*a* to a filter support surface 413*a*.

According to an embodiment shown in Figures 17 and 18, a cylindrical portion 513*c* connecting the sheets 513*b* of a filtration-compression diaphragm 513 at a slurry feed opening 510 is externally peripherally formed with a projection 513*g* while fitted between said cylindrical portion 513*c* and an opening 511*a* in a base plate 511 are a ring 550 having a groove in its inner periphery fitted on said projection 513*g* and an auxiliary ring 551 applied to a portion of the surface of said ring 550 and cooperating with the latter to define a groove 550*b* for clamping a projection 511*b* formed on the inner periphery of the opening 511*a*, said two rings 550 and 551 being joined together by bolts 552 and nuts 553. The rings 550 and 551 can each be split into two to facilitate mounting. The fitting and joining of the rings 550 and 551 can be performed when one sheet 513 has been inserted in the opening 511*a*.

In this embodiment, the rings 550, 551 and base plate 511, and the rings 550, 551 and compression diaphragm 513 are respectively prevented from being relatively displaced axially of the slurry feed opening 510. The fitting between the projection 513*g* and groove 550*a* does not interfere with the free bulging of the compression diaphragm 513.

According to an embodiment shown in Figure 19, a base plate 611 is thinned while the sheets 613b, of a filtration-compression diaphragm 613 are thickened. A main filtrate outlet channel 617*a* extends through the sheets 613*b* and base plate 611 to open to the marginal lands 613*d* of the sheets 613*b* while a filtrate outlet sub-channel 617*b* comprises through-holes 617*b*1 extending through the sheets 613*b* at corners of filter support surfaces 613*a* and grooves 617*b*2 formed in the opposite surfaces of the base plate 611 to communicate with said through-hole 617*b*1 and main outlet channel 617*a*.

In this embodiment, since the filtrate outlet passageway is constituted by the two linear through-holes 617*a* and 617*b*1 and the grooves 617*b*2 establishing the communication therebetween, said passageway can be easily formed. The filter plate 608 formed with the filtrate outlet passageway is clamped by the marginal lands of other filtrate plates, as in the preceding embodiments, whereby the communication of the pressure chamber 612 with the outlet channels 617*a* and 617*b* is prevented. In addition, if a core member 660 is embedded in each sheet as shown in phantom lines, this serves for reinforcement and for fluid-tightness.

According to an embodiment shown in Figure 20, a filter polate 708 comprises a thin base plate 711 and a filtration-compression diaphragm 713 having thickened sheets 713*b*, as in the case of Figure 19. A main filtrate outlet channel 717*a* extends through the sheets 713*b* and base plate 711 to open to the marginal lands 713*d* of the sheets 713*b* while filtrate outlet sub-channels 717*b* each comprises a through-hole 717*b*1 extending through the associated sheet 713*b* at a corner of its filter support surface 713*a*, and a groove 717*b*2 formed in the rear surface of the associated sheet 713*b*.

In this embodiment, the filtrate outlet passageway comprises through-holes 717*a* and 717*b*1 and the grooves 717*b*2, and said passageway can be easily formed, as in the preceding embodiment.

It is to be understood that the invention is

not limited to the embodiments described above and that changes may be made without departing from the spirit of the invention.

WHAT WE CLAIM IS:-

1. A filtration-compression type filter press, comprising; compression filter plates disposed between a fixed end plate and a movable end plate, each compression filter plate comprising a base plate centrally formed with an opening larger than a slurry feed opening and a filtration-compression diaphragm which comprises two flexible sheets which have uneven filter cloth-supporting surfaces and which are connected together by an integrally formed cylindrical portion thereof extending through the opening in the base plate and formed with said slurry feed opening, said base plate and diaphragm cooperating with each other to define compression chambers, a filtrate outlet channel communicating with the filter chambers defined between the plates and a pressure fluid feed channel which opens to each compression chamber, said pressure fluid feed channel comprising a main pressure fluid feed passage extending through the base plate and sheets of each filter plate and adapted to communicate with a pressure fluid feed port in the fixed end plate when the filter plates are clamped, and pressure fluid feed sub-channels which establish the communication between said passage and each compression chamber, while the filtrate outlet channel comprises a main filtrate outlet passage extending through the base plate and sheets of each filter plate and adapted to communicate with a filtrate outlet port in the fixed end plate when the filter plates are clamped, and filtrate outlet sub-channels which communicate with said main filtrate outlet passage and which open to the uneven filter cloth-supporting surfaces defined by the sheets.

2. A filtration-compression type filter press as set forth in claim 1, wherein the size of the opening in each base plate is such that one of the sheets of the filtration-compression diaphragm, when wadded, can be passed therethrough.

3. A filtration-compression type filter press as set forth in claim 2, wherein the filtrate outlet subchannels comprise grooves in the sheet surfaces.

4. A filtration-compression type filter press as set forth in claim 2, wherein the filtrate outlet sub-channels comprise passageways formed in the base plate and openings in the filter cloth-supporting surfaces communicating therewith.

5. A filtration-compression type filter press as set forth in claim 2, wherein the filtrate outlet subchannels include at least one passageway formed between the contact surfaces of the base and a sheet of each filter plate.

6. A filtration-compression type filter press as set forth in claim 5, wherein the passageway formed between the contact surfaces of the base plate and sheet comprises a groove formed in one of the contact surfaces.

7. A filtration-compression type filter press as set forth in claim 1, including means for preventing the relative displacement between the filtration-compression diaphragm and base plate.

8. A filtration-compression type filter press as set forth in claim 7, wherein the displacement preventing means comprises connecting the upper edge of each sheet to the base plate by connectors.

9. A filtration-compression type filter press as set forth in claim 7, wherein the displacement preventing means comprises a hook formed on the upper edge of each sheet for engagement with the upper edge of the base plate.

10. A filtration-compression type filter press as set forth in claim 7, wherein the displacement preventing means comprises peripheral projections adapted to be fitted in the opening in the base plate.

11. A filtration-compression type filter press as set forth in claim 7, wherein the displacement preventing means comprises a ring interposed between the cylindrical portion of the filtration-compression diaphragm and the opening in the base plate.

12. A filtration-compression type filter plate as set forth in claim 11, wherein the ring is diametrically split into two.

13. A filtration-compression type filter press as set forth in claim 11, wherein a plurality of rings which can be removably fitted together are used.

14. A filtration-compression type filter press as set forth in claim 11, wherein the ring is adapted to engage with a projection formed on the peripheral surface of the cylindrical portion of the filtration-compression diaphragm and also with a projection formed on the inner periphery of the opening in the base plate.

15. A filtration-compression type filter press as set forth in claim 14, wherein the ring is split into two at the groove which engages with the projection on the periphery of the opening in the base plate.

16. A filtration-compression type filter press as set forth in claim 1, wherein the compression filter plates have a main pressure fluid feed passageway and each filter plate has a pressure fluid feed sub-passageway which communicates with said main passageway and opens to the cloth-supporting surfaces and wherein there are provided a bypass extending from the pressure fluid feed channel which opens to said compression chambers to the main pressure

fluid feed passageway which communicates with the filter cloth-supporting surfaces, and a valve for suitably opening and closing said bypass.

17. A filtration compression type filter press as set forth in claim 16, wherein the main pressure fluid feed passageway which communicates with the filter cloth-supporting surfaces is also a washing liquid feed passageway.

18. A filtration-compression type filter press as set forth in claim 16, wherein the compression filter plates are alternate with ordinary filter plates and each ordinary filter plate has a marginal land adapted to be pressed against the portion of the associated sheet of the compression filter plate where the filtrate outlet channel is formed.

19. A filtration-compression type filter press, constructed arranged and adapted to operate substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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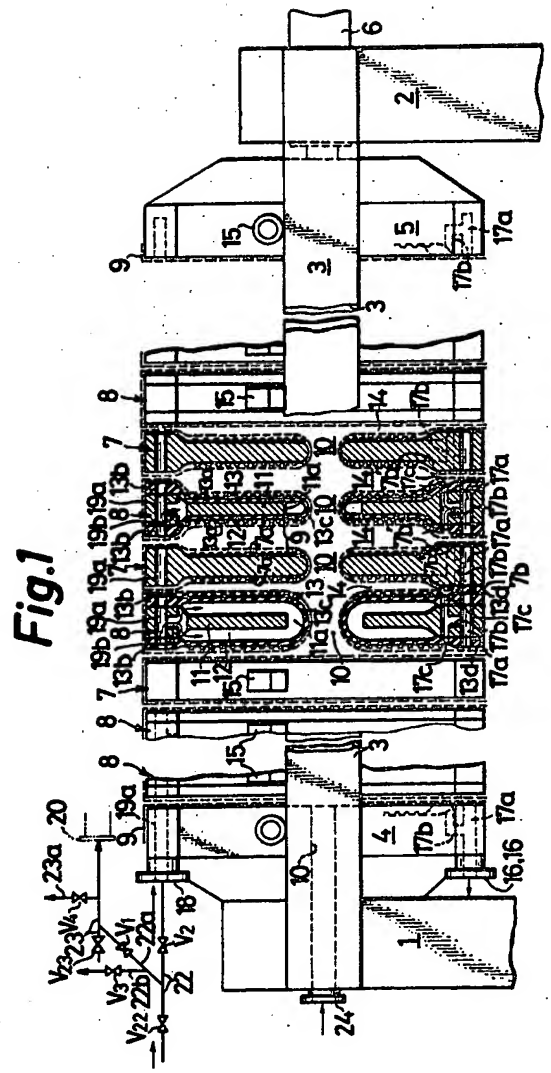

Fig.1

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Sheet 2

Fig.2

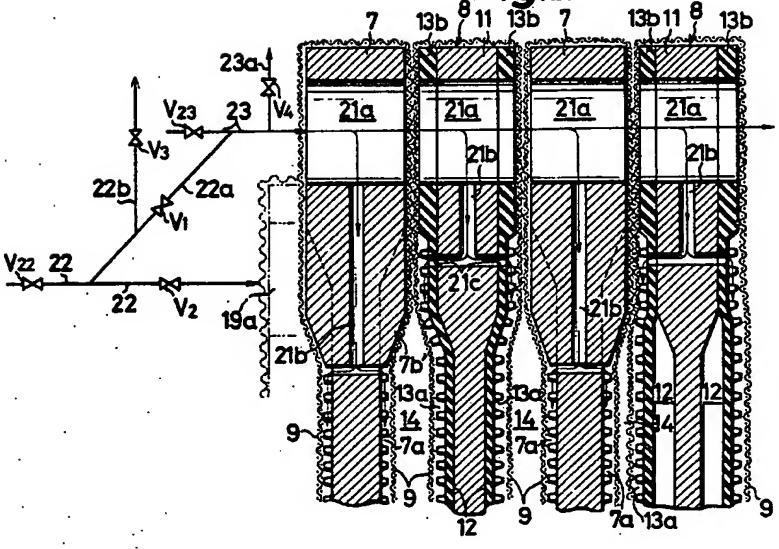

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Fig.3

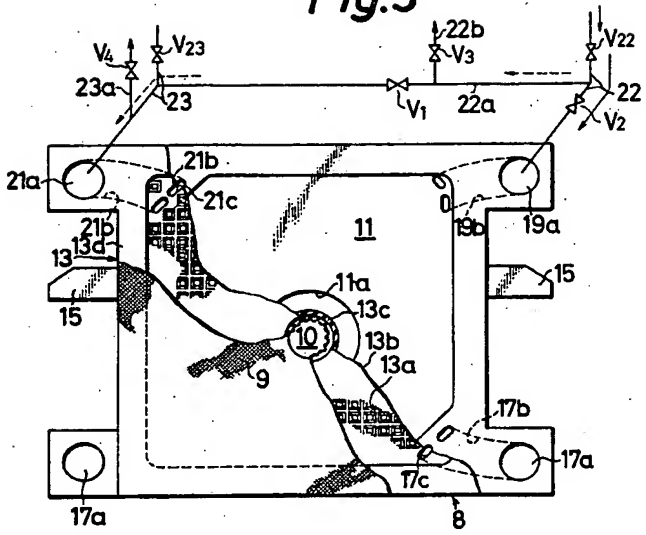
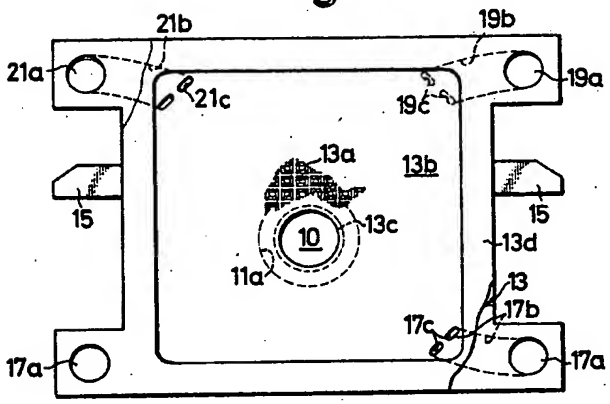


Fig.4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21a
21c
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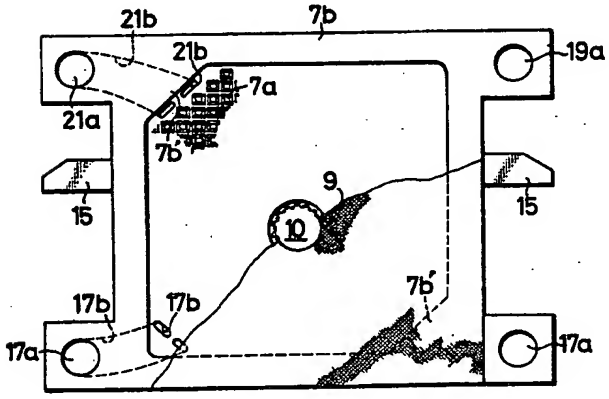
13b
15
15
10
13c
13d
11a
13
17b
17c
17a
17a

Fig.5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21b
19a
7a
21a
7b'
9
15
15
10
17b
17b
7b'
17a
17a

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Fig.6

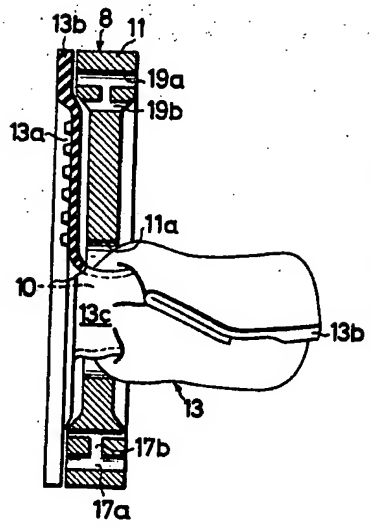

Fig.7

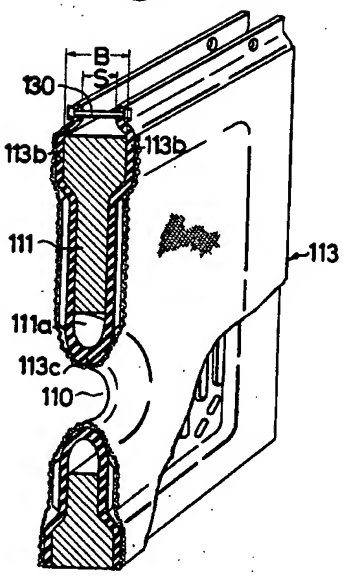

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Fig.8

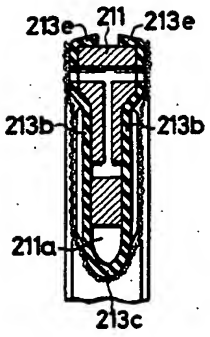

Fig.9

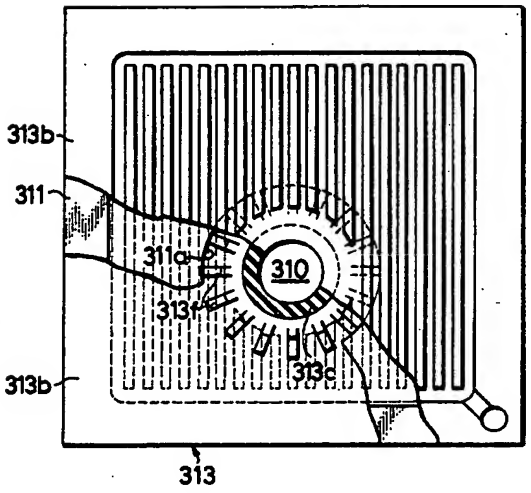

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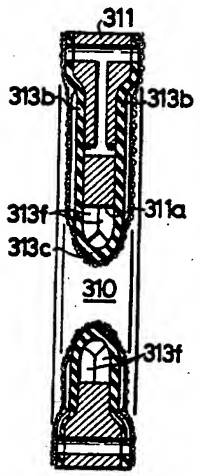
Fig.10



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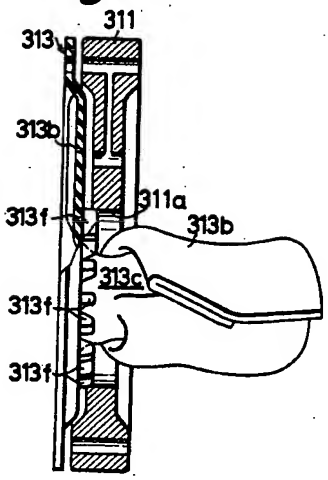

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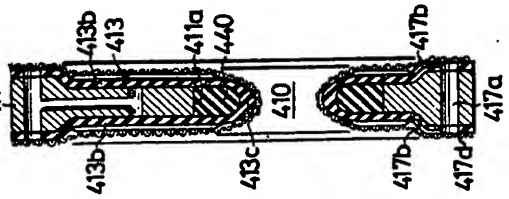
Fig.13



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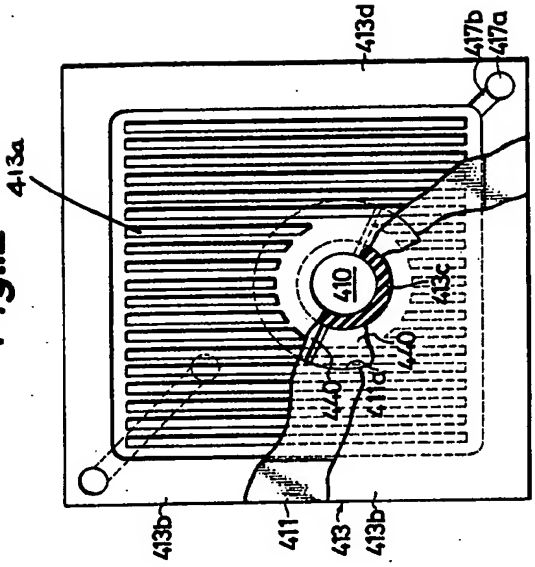

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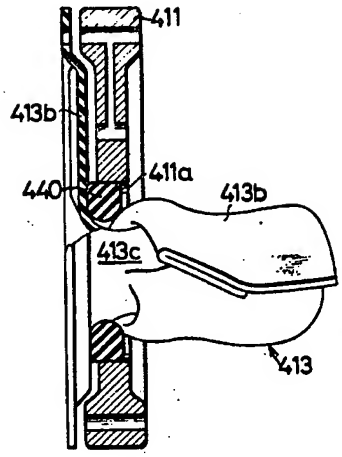
Fig.14



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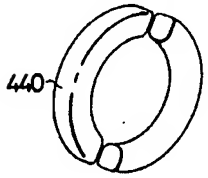
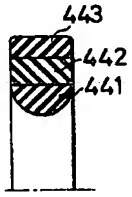


Fig.16



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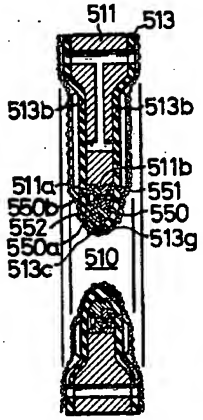

Fig.18

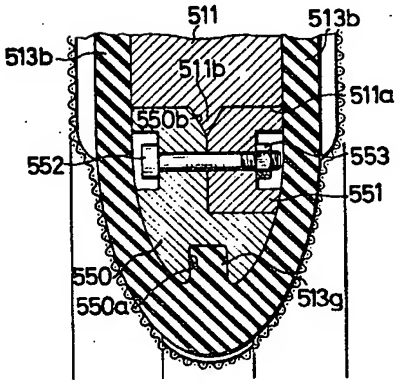

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Fig.19

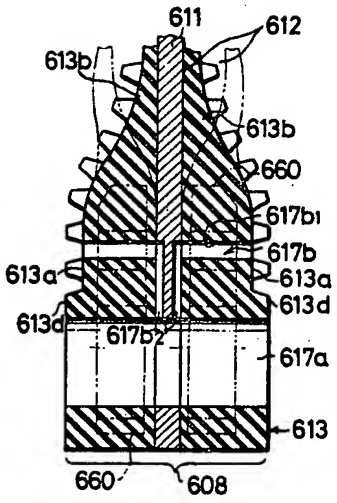
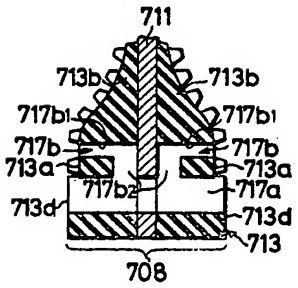


Fig.20



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